

MALARIA IN PRIMARY SCHOOL CHILDREN AND INFANTS IN KINSHASA, DEMOCRATIC REPUBLIC OF THE CONGO: SURVEYS FROM THE 1980S AND 2000

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Abstract. Kinshasa, the capital of the Democratic Republic of the Congo, has been a perennial malarious area and has grown almost 14 times from 380,000 people in 1960 to 5,293,000 in 2003. The most complete information on malaria prevalence in Kinshasa was first acquired in 1981–1983. Blood smears were obtained from 25,135 children (ages 5–15 years) from 245 schools in 16 of 24 zones. The mean *Plasmodium falciparum* parasite rate was 17%; the parasite rate was similar for both sexes and was higher ($P < 0.001$) in older students. The parasite rate varied from 4% (urban zone) to 46% (peri-urban zone). An infant survey confirmed malaria transmission. During the Roll Back Malaria situational analysis in 2000, malaria prevalence was reassessed by the National Malaria Control Program and its partners in schools from selected health zones. A mean parasite rate of 34% was found among school children 5–9 years old. The parasite rate varied from 14% (central urban zone) to 65% (peri urban zone). *Plasmodium falciparum* was not the only species found, but accounted for more than 97% of the infections. Malaria incidence may have increased in Kinshasa during the last two decades due to difficulties in provision of control and prevention measures. Along with deployment of insecticide-treated bed nets and improved patient management, currently ongoing, other measures that could impact the disease are being considered, including vector control, water management, and proper urban planning.

INTRODUCTION

Malaria is primarily a rural disease, but can be a serious problem in urban areas.^{1–5} Major cities in the lesser-developed countries of central Africa have the potential for a serious increase in malaria incidence because they lie in a belt of perennial transmission.⁶ Urban centers are experiencing high population growth due to the migration of people from rural, malaria-endemic areas to outlying areas of cities where the topography favors the malaria vector and disease transmission. Malaria transmission has continued unchecked in the cities because larviciding, adulticiding, and anopheline breeding site-source reduction have not kept pace with growth.⁵ Since these cities are usually major international centers, the disease can be exported to nonmalarious areas.

BACKGROUND

Kinshasa, the capital of the Democratic Republic of the Congo, is a prime example of an urban population explosion. Its population has grown from 380,000 in 1960 to 2,700,000 in 1982 and to more than 5,293,000 in 2003, an increase of almost 14 times in 40 years. The city is administratively divided into 24 administrative zones or communes that cover some 9,965 km². According to the national health policy, 24 health zones (HZs) roughly cover the 24 administrative zones. One zone, Maluku, has an area of 7,948 km² or 80% of the area. Kinshasa is on the southern bank of the Congo River and part of its peri-urban area is bordered by a large marsh with an area of approximately 65 km². Water collection in the numerous small rivers, streams, and ditches that flow through Kinshasa to the Congo River and the marsh provide ideal breeding sites for the malaria vectors. In 1977, Ward found *Anopheles gambiae* in most types of water, including polluted water, in Kinshasa.⁷ *Anopheles gambiae* were also found in inactive irrigation canals, seepage pools in oxbows of river beds, river water collections in oxbows with hyacinth cover, tail water from small plot farms, still water eddies along margins of shallow rivers, and sand pits.⁸

Historically, Kinshasa has been a malarious area.^{7,9–14} The

most complete information on malaria prevalence in Kinshasa was acquired by the Program de Lutte Antipaludique, a malaria pilot project created by an agreement in 1976 between the United States Agency for International Development (USAID) and the Government of Zaire (now the Democratic Republic of the Congo; Program de Lutte Antipaludique is now the Programme National de Lutte Contre le Paludisme). The main objective of the project was to train vector control personnel to implement and evaluate malaria vector control measures in four (Ndjili, Masina, Kimbanseke, and Limete) of the 24 zones of Kinshasa and in a rural area. These zones were chosen for historic, geographic, and logistic reasons. Ndjili, Masina, and Kimbanseke are peri-urban and new settlements, while Limete is an old central urban zone. Operational activities began in the zone of Ndjili in 1979 and in the zones of Limete, Masina, and Kimbanseke in 1980. The primary anopheline mosquito control measure was intradomestic spraying with DDT. Evaluation consisted of semi-annual blood smear surveys of primary school children in 31 schools and from approximately 15% of all children up through nine years of age in the four zones. As the project progressed, information on the distribution of malaria in the other zones of Kinshasa was needed to provide baseline data for planning future control activities. To obtain this information, school surveys were conducted during an 18-month period, beginning in late 1981. Because surveys were carried out at different times and under varying conditions, results from some of the zones might not reflect the periods of highest transmission. However, the data obtained were considered a useful estimate of the seriousness of the disease in each zone because malaria prevalence in the four pilot zones was stable throughout the year.

In addition to the school surveys, a 15-month study was conducted in the Limete zone where newborns from two hospitals were registered monthly. Efforts were made to collect monthly blood smears from all infants registered during that period. In late 1980s, with the interruption of the bilateral cooperation, USAID left Kinshasa and malaria activities stopped.

In 1998, a new malaria control program, the Program Na-

tional de Lutte contre le Paludisme, was set up by the Ministry of Health with the aim of resuming and coordinating malaria control activities in the country. In 1999, the country endorsed the global "Roll Back Malaria" (RBM) strategy. In 2000, to develop effective control strategies, the Program National de Lutte contre le Paludisme, with the support of its partners, reassessed the current malaria situation in Kinshasa. One area thus explored was the prevalence of infections in school children. These recent findings are reported in this paper.

MATERIALS AND METHODS

Early surveys (1981–1983). A list of the primary schools in each of the 24 zones was obtained from the Department of Education or from zonal offices. Each school was located on a city map for field personnel use and for plotting malaria prevalence by zone. The zones to be surveyed were listed by priority according to ecologic differences, population, survey cost, availability of transport, and personnel requirements. Program personnel visited the schools, zone by zone, to inform the authorities about the survey and administer a questionnaire requesting current information on the number of students, age and sex, classes, school sponsor, antimalaria drugs used for students who complained of fever, and willingness to cooperate in establishing treatment and chemoprophylaxis programs for the students. Authorities at each school were also informed that at a second visit 100 thick and thin blood smears would be taken from 25 students in four classes. Both students and classes were selected by a table of random numbers.

If a chosen class contained more than 25 students, the survey team leader would arbitrarily take smears beginning from either the front, middle, or rear of the line. Only students from the zone being sampled were included, but this residency requirement could be as short as one day. Any child reporting a fever at the time the smear was taken was treated with a single dose (10 mg base/kg of body weight) of amodiaquine. *Plasmodium falciparum* was sensitive to the 4-aminoquinoline drugs in Kinshasa at the time the surveys were performed. The blood smears were stained with Giemsa, and 100 thick smear fields were examined on each smear. The thin smear was used for species identification. Students with a malaria-positive smear were given a 25-mg/kg dose of amodiaquine base divided (10 mg/kg, 10 mg/kg, and 5 mg/kg) over a three-day period.

To assess whether transmission was occurring in Kinshasa, infants born in two hospitals in Limete zone were registered. This was done monthly for 15 months. Visits to the infants each month were made to monitor their malaria status during the past month.

Informed consent was obtained following the procedures of the Program de Lutte Antipaludique. Verbal consent was obtained from the administrator of each school for the prevalence survey and for standard treatment of all students who were positive for malaria. In turn, school administrators were responsible for obtaining parental consent. Verbal consent was also obtained from the guardians of each infant enrolled in the newborn infant follow-up survey. Obtaining blood smears and treatment of confirmed malaria was a routine operational procedure of the Program de Lutte Antipaludique at the time these surveys were carried out.

Recent surveys (2000). From February through April 2000, 10 primary schools were randomly selected in 10 HZs from 8 communes (Barumbu [one school in the Kin-Malebo HZ], Kalamu [one in the Kalamu HZ], Kimbanseke (two, one in the Kikimi HZ and one in the Kimbanseke HZ), Limete (one in the Funa HZ), Ndjili (one in the Ndjili HZ), Ngaba (one in the Ngaba HZ), Ngaliema [one in the Binza Meteo HZ], and Ngiri-Ngiri [one in the Mboka Sika HZ]). In each school, only students 5–9 years old were targeted. A 100-blood smears sample was collected from students that were present. Blood smears were stained with Giemsa and read by an experienced microscopist. In September 2000, this survey was repeated in 5 of these 10 schools from 5 communes (Barumbu, Kalamu, Kimbanseke [Kikimi HZ], Ngaba, and Ngaliema). During this second stage, only students living in the HZ area were included in the sample to allow for comparison between different sites. Students who were positive were given sulfadoxine-pyrimethamine (SP) in a single dose (1.25 mg/kg of body weight of pyrimethamine plus 25 mg/kg of body weight of sulfadoxine). This was done because a recent *in vivo* drug study confirmed its efficacy, as well as a high level of chloroquine resistance.¹⁵ Sulfadoxine-pyrimethamine was the second-line antimalarial drug when the surveys were done.

In the Democratic Republic of the Congo, the Ministry of Health has an ethical committee that is responsible for reviewing and approving studies involving humans. Although this survey was considered a routine procedure of minor risk, it was reviewed and approved by a Ministry of Health technical committee board. A letter describing the purpose of the survey was sent to the administrators of the selected schools and the health authorities of the governmental units involved. A team from the National Malaria Control Program explained the protocol and the advantages and disadvantages of the survey to the school officials and local authorities. The parents of the children were also contacted for informed consent. Survey staff held meetings with parents, teaching staff, and parent/school committees. The survey was conducted once consent was obtained.

RESULTS

Early surveys (1981–1983). In 1981, the 24 zones had 498 primary schools with 6,885 classes, 324,239 students were registered in the 498 schools, the boy-girl ratio was 1:1, approximately 49% of the students were 5–9 years old, 48% were 10–14 years old, and 3% were ≥ 15 years old (Table 1). The 1982 population Kinshasa census showed that approximately

TABLE 1
Student demographics from 498 primary schools in the 24 zones of Kinshasa, Zaire, 1981–1983

	Male	Female	Total
Students enrolled	161,870	162,369	324,239
Percent	50	50	100
Students by age group (years) and sex			
5–9	79,885	79,354	159,239
10–14	77,493	78,596	156,089
≥ 15	4,492	4,419	8,911
Percent by age group and sex			
5–9	49	49	49
10–14	48	48	48
≥ 15	3	3	3

47% of the 5–14-year-old population attended primary school.

Analysis of the questionnaire data from 192 schools in nine zones indicated that 20% of the schools were run by the government; the rest were operated by religious, voluntary, or private organizations. Only one school provided malaria drugs to students complaining of fever, and all but one indicated they would cooperate with curative or preventive programs if drugs were made available.

Table 2 summarizes results of 25,135 blood smears collected from 245 schools in 16 zones over an 18-month period from 1981 to 1983. These data include the 31 schools of the 4 pilot project zones. A total of 4,364 smears (17%) were positive for *P. falciparum*, the only species detected. Zone parasite rates varied from 4% in Lingwala (downtown Kinshasa) to 46% in Mont Ngafula (a peri-urban area). Within zones, the individual school parasite rates varied from 0% to 10% in Lingwala, and from 15% to 84% in Mont Ngafula. Of the 245 schools, 3 (1%) had no malaria cases, 100 (41%) were found to have parasite rates of 1–9%, 47 (19%) schools had rates of 10–20%, 82 (33%) schools had rates of 21–49%, and 13 (5%) schools had parasite rates $\geq 50\%$. Figure 1 shows the location of 16 of the 24 zones surveyed, the distribution pattern of the schools within a zone, and the range of slide-positivity rates found in the schools. Two rural zones (Nsele and Maluku), five urban zones (Kinshasa, Gombe, Bandalungwa, Kasavubu, and Kintambo), and one urban to semi-urban zone (Ngaliema) were not surveyed because of funding limitations and the termination of the pilot project.

Of the 21,894 smears examined in 13 of the zones, 4,078 (19%) were positive (Table 3). Forty-three percent of the smears and 40% of the positive results were from the 5–9-year-old group, 53% of the smears and 55% of the positive results were from the 10–14-year-old group, and 4% of the smears and 5% of the positive results were from the ≥ 15 year-old group. There was no significant difference in parasite rates by sex in any age group, but the parasite prevalence rates increased significantly ($P < 0.001$) with age. The slide positivity rates of newborn infants from one zone (Limete) that were followed for up to 15 months to develop information on transmission, as shown in Table 4. The parents stated

that none of the infants had been outside Kinshasa. The *P. falciparum* slide positivity rate varied from 0 in infants less than one month of age to 3.1% in six-month-old infants and to 14.3% in 14-month-old infants.

Recent surveys (2000). Blood smears were collected from 503 students 5–9 years old in five schools from five HZs in five communes of Kinshasa. The findings are shown in Table 5. Among the 503 blood smears, 170 (34%) were positive. The parasite rate ranged from 14% in Barumbu (old central-urban) to 65% in Ngaliema (new peri-urban). The 15% slide positivity rate found in Kikimi (new peri-urban) was unexpected. Among the 170 positive blood smears, 2 had *P. malariae*; thus, *P. falciparum* was not the only malaria species present in Kinshasa.

DISCUSSION

The presence of malaria in Kinshasa was reported in 1925,⁹ and Ward⁷ noted that at the end of the 1973 rainy season (July) the malaria prevalence rate was approximately 25% in the more newly developed areas of Kinshasa. Furthermore, Kageruka and others¹¹ reported that the slide positivity rate was 19% in Ndjili (peri-urban) and 8% in Nsele (semi-rural). This survey shows the geographic range of the malaria problem and delineates the zones of highest priority for malaria control. The intensity of the problem was not totally unexpected because hundreds of thousands of people have migrated from rural malaria-endemic areas to the city. However, the increase in the parasite rate with age was not expected. Younger school children become sicker with malaria and remain home or receive treatment more often, while older children, due to increasing immunity, remain ambulatory and attend school. In Brazzaville, a higher malaria prevalence in older children was attributed to the increased use of antimalarial drugs, particularly in early childhood.¹⁶

Because of frequent population movement, a number of the malaria cases found in the school survey may have been imported. However, *An. gambiae* and malaria transmission have been confirmed in Kinshasa, and *An. gambiae* has been detected in polluted water.^{7,8} Entomologic surveys also found substantial numbers of both *An. gambiae* and *An. funestus*

TABLE 2
Results of the malaria surveys in Kinshasa schools, 1981–1983

Zone	Schools visited	Smears examined	Smears positive	% Positive	Number of schools with smear positivity of				
					0%	1–9%	10–20%	21–49%	$\geq 50\%$
Barumbu	13	1,300	57	4	0	12	1	0	0
Bumbu	7	700	147	21	0	0	3	4	0
Kalamu	30	2,995	220	7	0	24	4	2	0
Kimbanseke	10	994	185	19	0	3	1	6	0
Kisenso	24	2,385	746	31	0	0	3	18	3
Lemba	26	2,598	212	8	0	20	2	4	0
Limete	4	400	91	23	0	0	2	2	0
Lingwala	9	1,305	45	4	1	7	1	0	0
Makala	22	2,200	688	31	0	0	3	18	1
Masina	9	900	144	16	0	0	8	1	0
Matete	27	2,700	230	9	0	19	7	1	0
Mont Ngafula	18	1,727	796	46	0	0	1	9	8
Ndjili	8	799	89	10	0	4	4	0	0
Ngaba	10	996	83	9	0	6	3	1	0
Ngiri-Ngiri	9	1,236	94	8	2	5	1	1	0
Selembao	19	1,900	537	28	0	0	3	15	1
Total	245	25,135	4,364	17	3	100	47	82	13

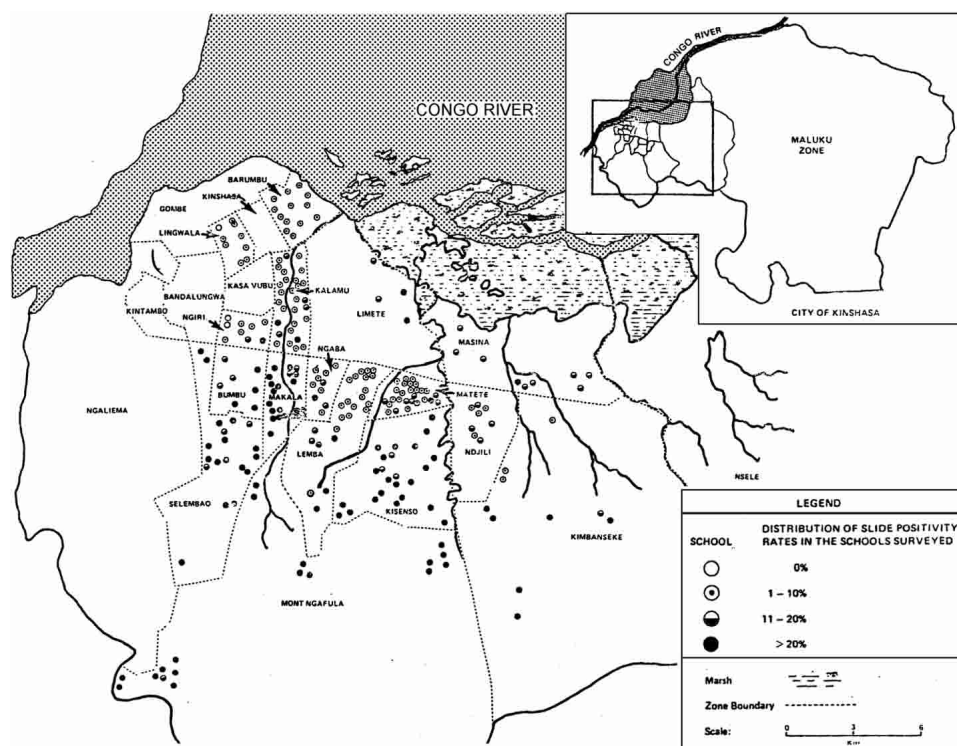


Figure 1. Distribution of slide positivity rates among schools surveyed in Kinshasa, Zaire, 1981–1983.

throughout the year in the four malaria pilot project zones (Sexton JD, unpublished data). In addition to establishing vector presence, the newborn infant follow-up study found malaria infections in infants of Limete zone who had never been outside Kinshasa. This finding indicates that transmission is occurring in Kinshasa.

During the surveys conducted in September 2000, a mean parasite rate of 34% was found, with the lowest rate (14%) in central urban zones (Barumbu, near the downtown area) and highest rate (65%) in the peri-urban zones (Ngalima, a semi-urban new settlement bordering the Congo River). Although the recent survey was relatively limited in time and space, and

the methodologies may not be strictly comparable, these findings support trends previously described in urban zones compared with peri urban ones. September is a period between the end of the dry season and the beginning of the rainy season in Kinshasa. Although malaria transmission is stable in Kinshasa throughout the year, the parasite rates were not expected to be so high at the time of this recent survey.

Such findings during a low transmission period would suggest an increase in malaria incidence. Indeed, such rates were not found at any time during previous surveys in Kinshasa or other urban settings, even among patients of the same age group. In Brazzaville, it was concluded that malaria transmis-

TABLE 3

Summary of blood smears examined from 13 zones of the Kinshasa school survey, by age and sex, 1981–1983

	Male	Female	Total
Smears examined	11,089	10,805	21,894
Smears positive	2,125	1,953	4,078
Percent smears positive	19	18	19
age group (years)			
5–9			
Examined	4,771	4,528	9,299
Positive	815	797	1,612
% positive	17	18	17
10–14			
Examined	5,851	5,134	11,685
Positive	1,194	1,050	2,244
% positive;	20	18	19
≥15			
Examined	467	443	913
Positive	116	106	222
% positive	25	24	24

TABLE 4

Malaria prevalence in infants from Limete Zone, Kinshasa*, Zaire, 1981–1982

Age (months)	Smears examined	Smears positive	% Positive
0	170	0	0
1	445	1	0.2
2	492	4	0.8
3	442	6	1.4
4	430	7	1.6
5	344	4	1.2
6	318	10	3.1
7	269	6	2.2
8	214	6	2.8
9	198	5	2.5
10	148	5	3.4
11	113	6	5.3
12	76	6	7.9
13	41	1	2.4
14	14	2	14.3

* None of these infants traveled outside Kinshasa.

TABLE 5
Prevalence of malaria infections in school children 5–9-years old in Kinshasa, September 2000*

Health zone	Location in the city	School visited	Smears examined	Smears positive	% Positive
Binza Meteo	Commune de Ngaliema (Peri-urban)	EP de la Rive	93	60	65
Kalamu	Commune de Kalamu (central urban)	EP III Yolo	111	33	30
Kikimi	Commune de Kimbanseke (peri-urban)	EP Saint Hilaire	100	15	15
Kin-Malebo	Commune de Barumbu (central urban)	EP III Barumbu	99	14	14
Ngaba	Commune de Ngaba (peri-urban)	EP Saint Adrien	100	48	48
Total			503	170	34

* EP = Ecole Primaire.

sion intensity could be related to an increasing population.¹⁷ When settlers first move to unoccupied land, they create conditions that favor the introduction and proliferation of *An. gambiae* and malaria transmission increases. As the human population increases, open spaces, formerly used as vector breeding sites, are eliminated and vector density decreases resulting in a lower vector dispersion. Malaria transmission becomes more focal and decreases as the human exposure to the vector is reduced. This appears to be occurring in Kinshasa because the older, more densely populated zones (including the more commercial zones) have lower prevalence rates compared with the peri-urban zones where most of the new residents settle. This was demonstrated in both surveys.

Following these recent findings (and those of the RBM situation analysis), control measures were initiated, focusing mainly on the deployment of insecticide-treated bed nets in the communities most affected, and the strengthening of patient-management through the adoption of a new antimalarial drug use policy (adopted in November 2001 with SP as the first-line drug) and the promotion of better practices through training of health workers, drug distribution, etc. This is being done with the support of many partners, including the USAID, the Centers for Disease Control and Prevention, Basic Support for Institutionalizing Child Survival, the World Health Organization, and the United Nations Children's Fund.

To ensure sustainability of these control measures, proper urban planning and implementing drainage and sanitary facilities and health services are the necessary long-range solutions to reduce malaria transmission in Kinshasa. For eliminating or reducing vector breeding, we support the previous recommendations to 1) channel and clean water courses, 2) open river oxbows, 3) remove emergent vegetation from fish ponds, 4) provide educational programs for farmers on proper fish pond and irrigation system construction and maintenance, and 5) implement larviciding and larvivorous fish programs.⁸ These measures are costly and they require extensive geographic knowledge about Kinshasa and considerable community participation. However, when compared with protecting the same population in a rural setting, the measures are cost-effective and would have a continuing benefit.

The need for elaborate control measures could be eliminated or reduced in many African cities if population increases were preceded, or, at least accompanied, by potable water systems, storm sewer drainage systems, and other water

management methods. Urban planning can prevent public health problems.

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